



Metals



101 minutes

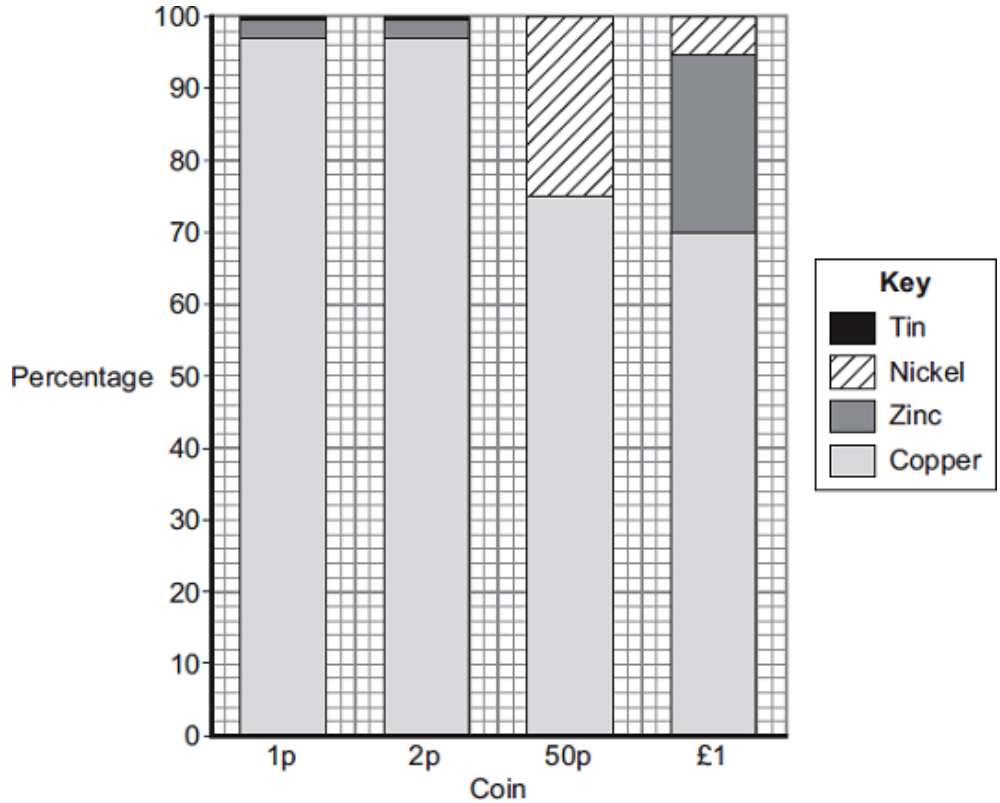


101 marks

Q1. This is the headline from a newspaper:

'Why is a 2p coin worth 3.3p?'

(a) The bar chart shows the percentage of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins?

.....

(1)

(ii) Which coin does **not** contain zinc?

.....

(1)

(iii) What is the percentage of nickel in a 50 p coin?

Percentage = %

(1)

(iv) Draw a ring around the correct metal to complete the sentence.

Pure copper is too soft to be used for 1 p and 2 p coins.

Copper is mixed with zinc and

iron
nickel
tin

 for 1 p and 2 p coins.

(1)

(b) The value of the metal in 2 p coins, made in 1991, is now 3.3 p.

Suggest why a 2 p coin made in 1991 is worth 3.3 p.

.....

.....

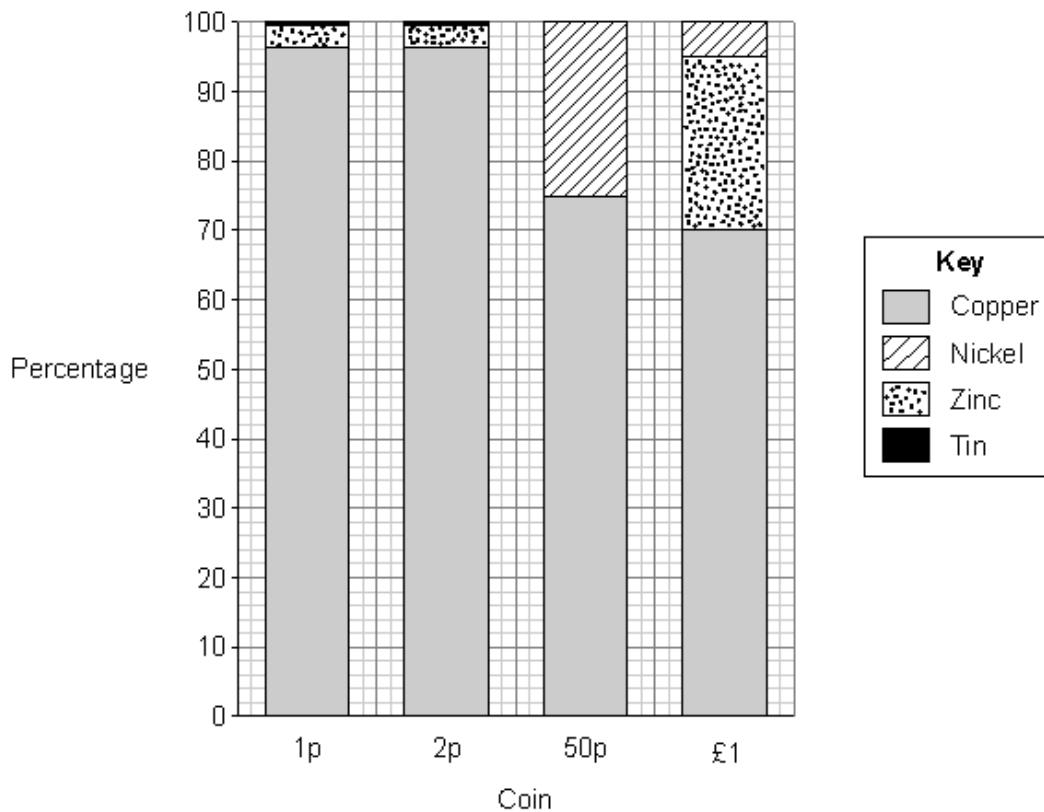
.....

(1)
(Total 5 marks)

Q2. This is a headline from a newspaper.

‘Why is a 2p coin made in 1991 now worth 3.3p?’

(a) The bar chart shows the percentages of metals in UK coins in 1991.



Use the bar chart to answer these questions.

(i) Which metal is in all of these coins? (1)

(ii) Which coin does **not** contain zinc? (1)

(iii) What is the percentage of nickel in a 50p coin? % (1)

(b) Suggest **two** reasons why a 2p coin made in 1991 is now worth 3.3p.
.....
.....
.....
.....

(2)
(Total 5 marks)

Q3. Iron is extracted from its ore.

(a) Iron ore is quarried.



Photograph supplied by Stockbyte/Thinkstock

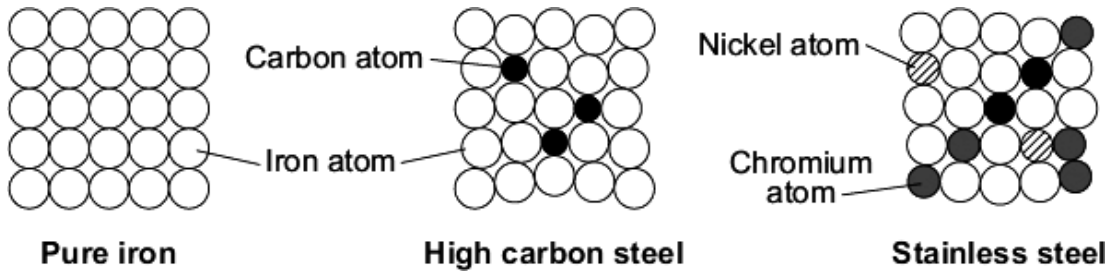
Quarrying iron ore has impacts that cause environmental problems.

Tick (✓) **two** impacts of quarrying that cause environmental problems.

Impact of quarrying	Tick (✓)
puts off tourists	
causes dust pollution	
increases jobs	
increases traffic	

(2)

(b) The diagrams represent the atoms in iron and the atoms in two alloys of iron.



Use the diagrams to help you to answer these questions.

(i) Complete the sentence.

Pure iron does **not** have many uses because

.....

(1)

(ii) Stainless steel is more expensive than pure iron.

Suggest why.

.....

.....

(1)

(c) Draw a ring around the correct answer to complete each sentence.

(i) Pure iron is

a compound.

an element.

a mixture.

(1)

(ii) High carbon steel is used for a drill bit because it is

brittle.

easily bent.

hard.

(1)

(iii) Stainless steel is used to make cutlery because it

contains three different atoms.
melts at a very high temperature.
is resistant to corrosion.

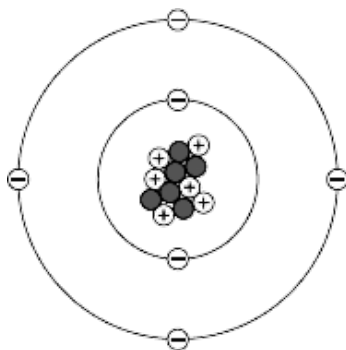
(1)
(Total 7 marks)

Q4. The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

(a) Diamond is a form of carbon. The diagram represents a carbon atom.



Complete the table to show the name and charge of each type of particle in the carbon atom.

Name of particle	Charge
proton	
neutron	0
	-1

(2)

(b) Use the Chemistry Data Sheet to help you to answer these questions.

(i) Draw a ring around the correct answer to complete the sentence.

Gold and carbon are

compounds.

elements.

mixtures.

(1)

(ii) Complete the sentence.

Gold and carbon have different properties because gold is a metal
and carbon is a

(1)

(c) Draw a ring around the correct answer to complete each sentence.

Pure gold is not used to make the ring because pure gold is too

hard.

reactive.

soft.

The gold ring is made by mixing pure gold with other metals to form

a compound.

an atom.

an alloy.

(2)

(d) The data in the table shows some information about the three metals in the gold ring.

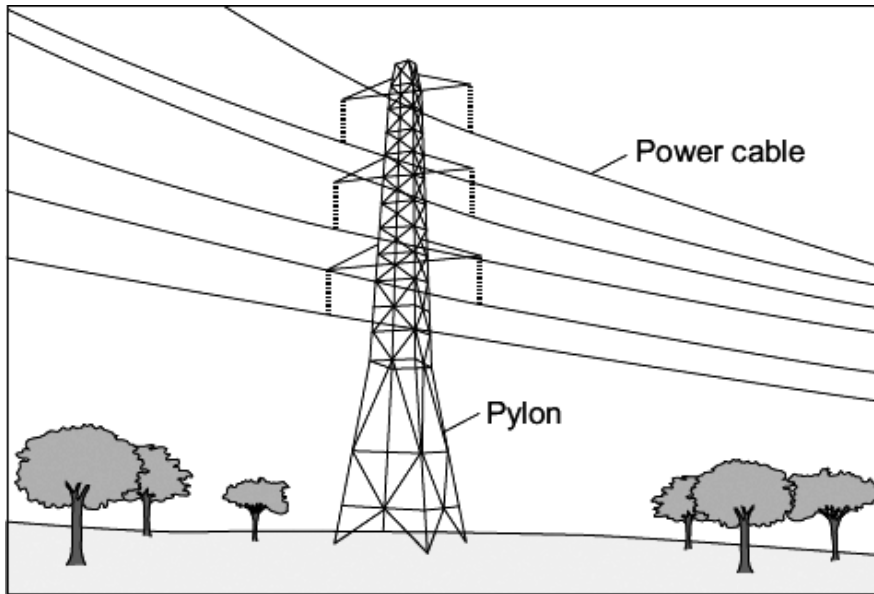
Name of metal	Atomic number	Percentage (%) of metal
gold	79	
silver	47	16
copper	29	9

Draw **one** line from each question to its correct answer.

Question	Answer
What is the percentage of gold in this ring?	29
How many electrons are there in a copper atom?	61
How many neutrons are in an atom of silver with a mass number of 108?	75
	79

(3)
(Total 9 marks)

Q5. Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

.....
.....

(1)

(b) The table shows some of the properties of two metals.

Metal	Density in g per cm ³	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

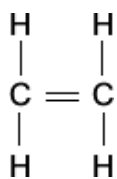
Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

.....
.....
.....
.....

(2)

(c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

(i) The chemical formula of this alkene is

CH

CH₄

C₂H₄

(1)

(ii) The two lines between the carbon atoms are called a

double bond.

nucleus.

single bond.

(1)

(iii) The name of the polymer formed when many of these alkene molecules join together

poly(ethene).

is poly(ethanol).

poly(propene).

(1)

(Total 6 marks)

Q6. The picture shows two different cars.



(a) Some properties of aluminium are given below.

Tick (✓) **two** reasons why aluminium is better than steel for car bodies.

Reason	Tick (✓)
Aluminium is not a transition metal.	
Aluminium has a low density.	
Aluminium is expensive to extract.	
aluminium is resistant to corrosion.	

(2)

(b) Each car body is made from an *alloy*.

(i) What is an *alloy*?

.....

(1)

(ii) An alloy is used to make a car body. A pure metal is **not** used to make a car body.

Suggest why.

.....

(1)

(c) The car with a steel body uses petrol for fuel.

Draw a ring around the correct answer to complete each sentence.

(i) Petrol is made from

- | |
|-----------------------------------|
| air.
crude oil.
metal ores. |
|-----------------------------------|

(1)

(ii) Petrol is a mixture of carbonates
hydrocarbons
polymers including C_8H_{18} (1)

(iii) In the car engine petrol reacts with argon
nitrogen
oxygen to produce carbon dioxide and water. (1)

(d) Look at the substances coming out of each car's exhaust.

(i) Suggest the name of the fuel used in the car with the aluminium alloy body.

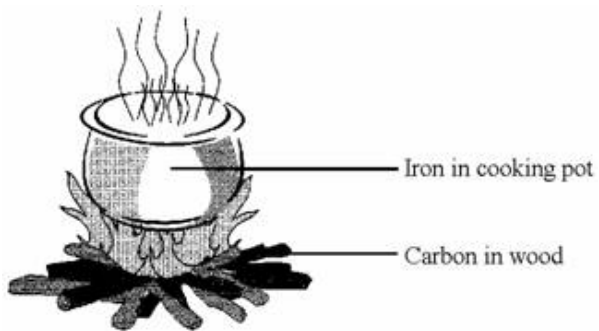
Name of fuel (1)

(ii) Why is the fuel burned in the car with the aluminium alloy body better for the environment than petrol?

.....
.....

(1)
(Total 9 marks)

Q7. The uses of *elements* depend on their properties.



(a) Carbon and iron are both *elements*. What is an *element*?

.....
.....

(1)

- (b) Complete the sentences by crossing out the words that are wrong. The first one has been done for you.

Non-Metals	Metals	can be hammered into shape.
-----------------------	--------	-----------------------------

Non-Metals	Metals	often have low melting point.
------------	--------	-------------------------------

Non-Metals	Metals	are good conductors of heat.
------------	--------	------------------------------

(2)

- (c) In the box are the names of three metals.

copper iron sodium

Which **one** of these is **not** a good metal for making the cooking pot? Give a reason for your answer.

Metal

Reason

.....

.....

(2)

(Total 5 marks)

- Q8.** Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.



By Sun Ladder (Own work) [CC-BY-SA-3.0 or GFDL],
via Wikimedia Commons

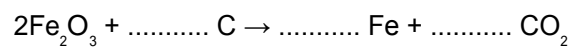
- (a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

- (i) Name this type of reaction.

.....

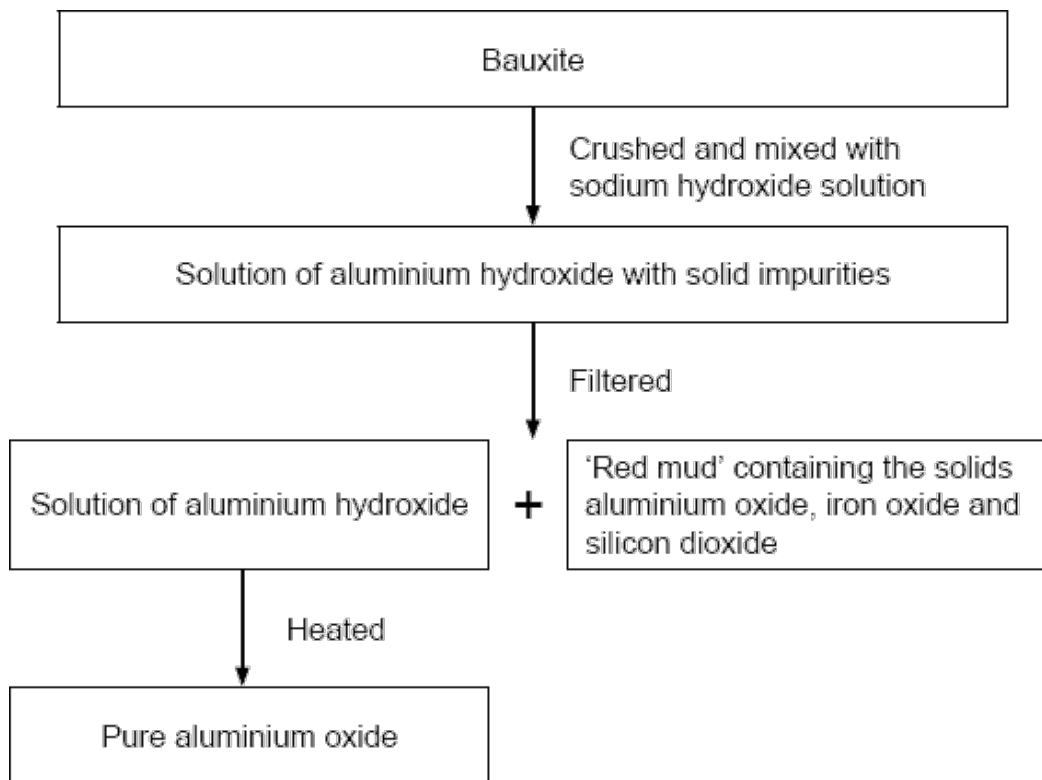
(1)

- (ii) Balance the symbol equation for this reaction.



(1)

- (b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide. Aluminium is extracted by electrolysis of aluminium oxide.



The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

- (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = %

(1)

- (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

.....

(1)

(iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

.....

(1)

(c) Aluminium is used to make many things including cans.

During one year in the USA:

- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental

.....

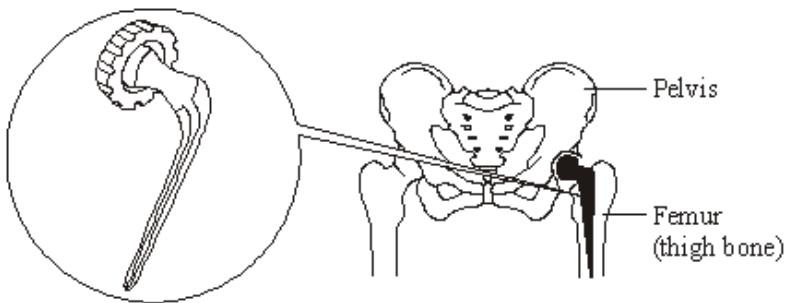
Ethical or social

.....

(2)

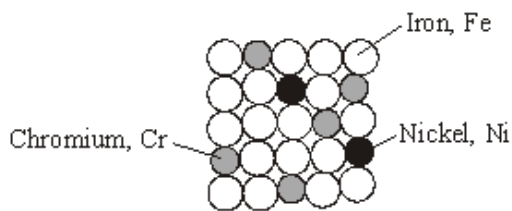
(Total 7 marks)

Q9. The hip joint between the femur and pelvis sometimes has to be replaced. Early hip replacement joints were made from stainless steel.



Stainless steel is an alloy of iron, chromium and nickel.

The diagram below represents the particles in stainless steel.



Particle diagram of stainless steel

(a) Use the particle diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

Element	Percentage (%)
Iron, Fe	72
Chromium, Cr	
Nickel, Ni	

(2)

(b) Pure iron is a relatively soft, metallic element.

(i) Why is iron described as an *element*?

.....
.....

(1)

(ii) Suggest why pure iron would **not** be suitable for a hip replacement joint.

.....
.....

(1)

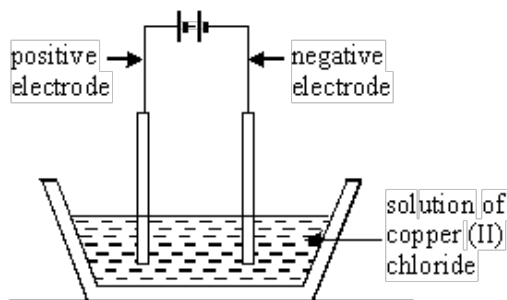
(iii) Use the particle diagram to help you to explain why stainless steel is harder than pure iron.

.....
.....
.....
.....

(2)

(Total 6 marks)

Q10. Copper metal can be extracted from a solution of copper(II) chloride.



Copper chloride is an ionic compound.

State where the copper would collect and explain your answer fully.

.....
.....
.....

(Total 2 marks)

Q11. Cassiterite is an ore of the metal tin.

(a) What is an ore?

.....
.....

(2)

(b) Some metals are obtained by removing oxygen from the metal oxide.

What name do we give to this chemical reaction?

.....

(1)

(c) Name **one** metal which must be extracted from its melted ore by electrolysis rather than by using carbon.

.....

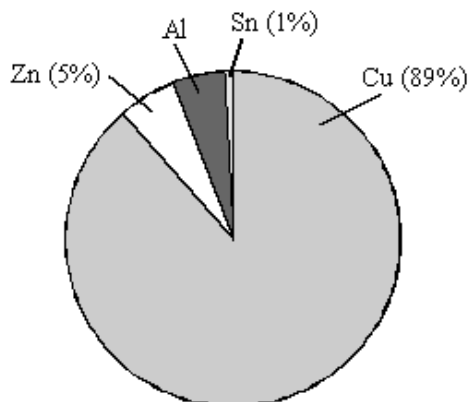
(1)

(Total 4 marks)

Q12. The 50 Eurocent coin is made from an alloy called 'Nordic Gold'.



The pie chart shows the percentage by mass of each metal in 'Nordic Gold'.



(a) (i) Calculate the percentage of aluminium, Al, in the coin.

.....

(1)

(ii) The 50 Eurocent coin has a mass of 7 grams.
Calculate the mass of zinc, Zn, in this coin.

.....

.....

Mass of zinc = g

(2)

(b) Zinc is extracted by removing oxygen from zinc oxide.

(i) What name is given to a reaction in which oxygen is removed from a substance?

.....

(1)

(ii) Explain how oxygen can be removed from zinc oxide to make zinc. Use the reactivity series on the Data Sheet to help you.

.....

.....

.....

(2)

(Total 6 marks)

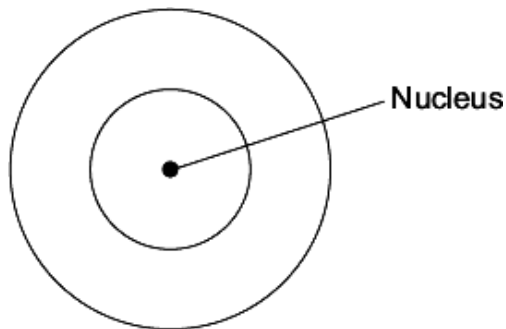
Q13. The picture shows a diamond ring.



Photograph supplied by Comstock/Thinkstock

(a) Diamond is a form of carbon. A carbon atom has six electrons.

Draw the electronic structure of a carbon atom.



(1)

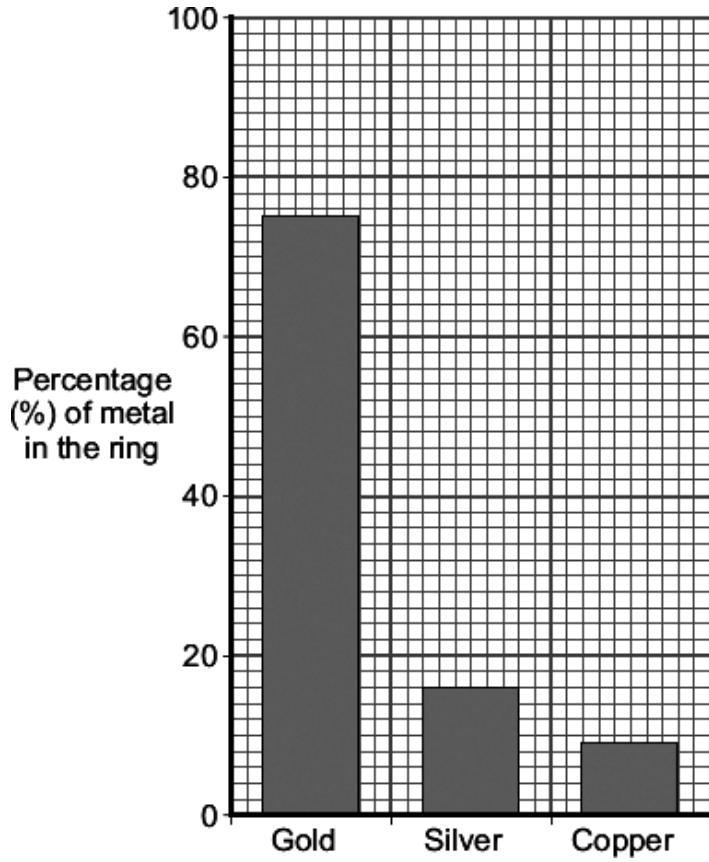
(b) A gold atom has an atomic number of 79 and a mass number of 197.

Complete the table to show the name and number of each sub-atomic particle in this gold atom.

Name	Number
Proton	79
Electron
.....

(3)

(c) The bar chart shows the composition of this gold ring.



(i) Give the percentage of the other two metals in this gold ring.

Silver is % and copper is %

(1)

(ii) This gold ring is not made from 100% gold.

Give **two** reasons why.

1

.....

.....

2

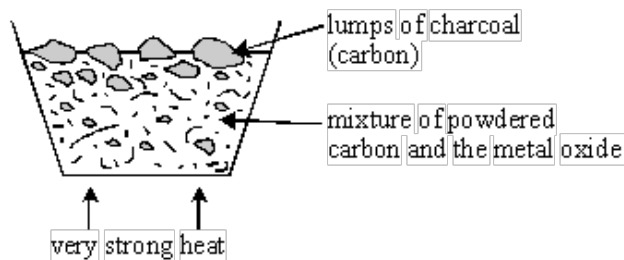
.....

.....

(2)
(Total 7 marks)

Q14. A student was trying to extract the metals from lead oxide and aluminium oxide.

She heated each oxide with carbon in a fume cupboard as shown below.



She was able to extract lead from lead oxide but not aluminium from aluminium oxide.

(i) Explain the results of these experiments.

.....

.....

.....

.....

.....

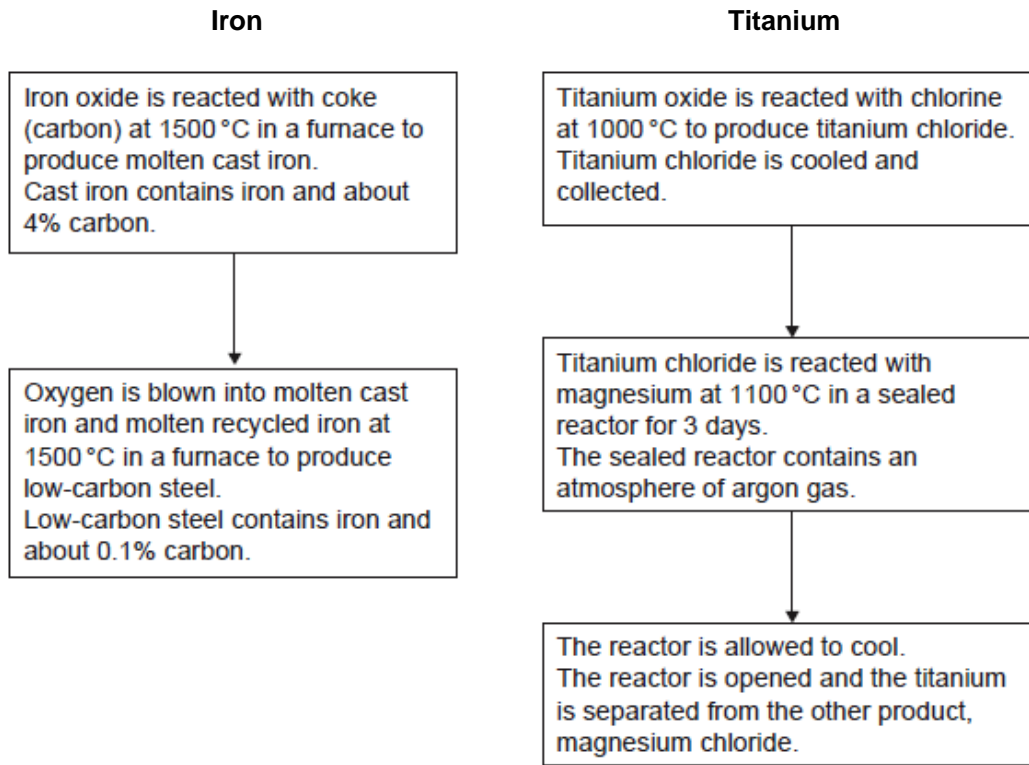
(ii) Complete this word equation for the reaction between lead oxide and carbon.

lead oxide + carbon → +

(Total 5 marks)

Q15. Iron is produced from the ore haematite (iron oxide).

Titanium is produced from the ore rutile (titanium oxide).



(a) The production of low-carbon steel uses oxygen but the production of titanium uses argon.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(b) There is less titanium than iron in the Earth's crust.

Apart from titanium's scarcity, explain why titanium costs much more than iron.

Use the two flow diagrams above to help you to answer this question.

.....

.....

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.....

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.....

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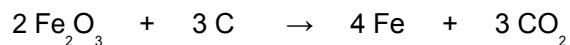
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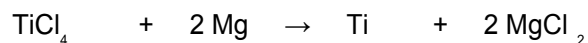
(3)

(c) Many chemical reactions take place in the production of both metals.

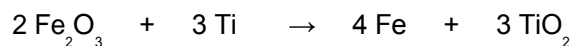
A chemical reaction in the production of iron is:



A chemical reaction in the production of titanium is:



Titanium can be used to produce iron from iron oxide. The chemical reaction is:



Use these three reactions and the Chemistry Data Sheet to answer this question.

Suggest the position of titanium in the Reactivity Series of Metals.

Explain your answer.

.....

.....

.....

.....

.....

(2)
(Total 8 marks)

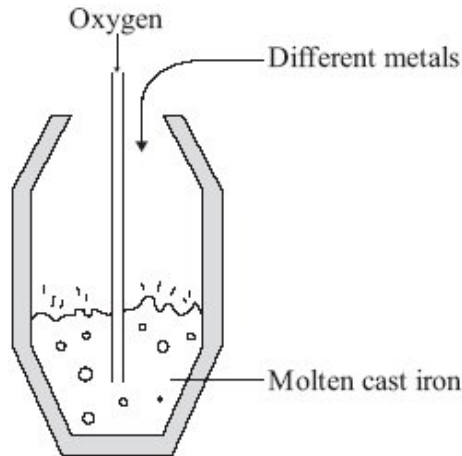
Q16. The demand for iron and steel is high.

- (a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



- (i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

.....
.....
.....
.....

(2)

- (ii) Why are different metals sometimes added to molten carbon steels?

.....
.....

(1)

(b) The percentage of iron and steel recycled in the UK has been increasing.

Year	%iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

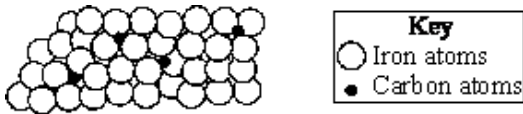
The UK government has set targets for the percentage of iron and steel to be recycled. In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

- 1
-
- 2
-

(2)
(Total 5 marks)

Q17. The diagram shows the arrangement of atoms in an *alloy*.



(a) What is meant by an *alloy*?

-
-

(2)

(b) Name the alloy represented in the diagram.

-

(1)

(c) Give **one** advantage of using this alloy instead of pure iron.

-
-

(1)

(d) Which elements are used to make brass?

.....

(1)
(Total 5 marks)

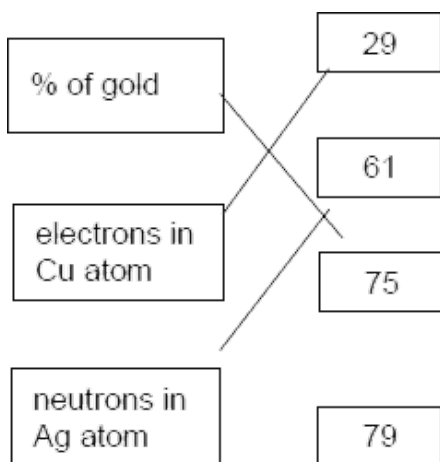
M1.	(a) (i) copper / Cu	1	
	(ii) 50 (p)	1	
	(iii) 25	1	
	(iv) tin	1	
	(b) any one form:		
	<ul style="list-style-type: none"> • high cost of <u>copper</u> <i>allow <u>metal</u> is expensive</i> • less copper available or (copper ores exhausted / only low-grade ores available) <i>allow <u>copper</u> is non-renewable</i> • high demand for copper • high percentage (%) of copper in the coin • inflation (of cost) 	1	[5]
M2.	(a) (i) copper	1	
	(ii) 50p	1	
	(iii) 25 (%)	1	
	(b) any two from:		
	<ul style="list-style-type: none"> • high value of copper <i>allow <u>copper</u> is expensive or contains other metals (that may have higher value now)</i> • less copper available or copper ores exhausted / only low-grade ores available <i>allow <u>copper</u> is non-renewable</i> • high demand for copper • inflation of prices 	2	[5]

- M3.** (a) causes dust pollution 1
- increases traffic 1
- (b) (i) it is soft
*accept the layers of atoms can slide over each other
 ignore other properties* 1
- (ii) contains chromium / nickel
allow contains other metals 1
- (c) (i) an element 1
- (ii) hard 1
- (iii) is resistant to corrosion 1

[7]

- M4.** (a) +1/+
*do **not** accept 1 without the +* 1
- electron
allow phonetic spelling 1
- (b) (i) elements 1
- (ii) non-metal 1
- (c) soft 1
- an alloy 1

(d)



one mark for each correct link
extra lines lose the mark

3

[9]

M5. (a) (iron (steel) is) strong

*allow abundant **or** easy to extract **or** cheap
ignore other correct properties*

1

(b) less dense

allow low mass

1

more abundant

*accept copper is 'running out'
allow copper is more expensive
ignore other correct statements*

1

(c) (i) C_2H_4

1

(ii) double bond

1

(iii) poly(ethene)

1

[6]

M6. (a) Aluminium has a low density

1

Aluminium is resistant to corrosion

1

- (b) (i) (an alloy) is a mixture of metals
*accept (an alloy) can be a metal mixed with another metal **or** iron
mixed with carbon / a non-metal* 1
- (ii) pure metals are soft
allow weak
- or**
- alloys are hard
*allow strong / keep their shape
 ignore rust / corrosion* 1
- (c) (i) crude oil 1
- (ii) hydrocarbons 1
- (iii) oxygen 1
- (d) (i) hydrogen
allow H₂ or H 1
- (ii) only water is produced (from the fuel)
- or**
- no carbon dioxide is produced (from the fuel)
*allow less carbon dioxide produced **or** less global warming
 allow carbon dioxide causes global warming* 1

[9]

- M7.** (a) made of atoms which contain the same number of protons
*accept made of only one type of atom
 accept cannot be broken down into anything simpler by chemical
 means* 1
- (b) non-metals 1
- metals 1

(c) sodium 1

too reactive (with water **or** air)

*accept has a low melting point **or**
will melt **or** not strong **or** will explode **or** will burn
do **not** accept dangerous (neutral)
do **not** accept iron as rusting **or**
copper **or** sodium as expensive (neutral)
do **not** accept not a good conductor of heat*

1

[5]

M8. (a) (i) reduction

accept redox / smelting

1

(ii) 3 4 3

1

(b) (i) 55

ignore other units

(ii) Water

*accept sodium hydroxide
accept correct formulae H_2O or $NaOH$*

1

(iii) any **one** from:

- save energy / fuel for transporting the ore
accept less (cost of) transport allow transported quickly
- (old) quarries nearby for waste/red mud

1

(c) **Environmental**

any **one** from:

- less mining / quarrying (of bauxite)
allow loss of habitat / less qualified noise pollution
- less landfill space needed / used
allow less red mud / waste
- less use of fossil fuels / energy
- less carbon dioxide produced

1

Ethical or social

any **one** from:

- saves resources
allow using resources more than once
- creates (local) employment
if answers reversed and both correct award 1 mark
- more people aware of the need for recycling
allow less qualified noise pollution if not given in environmental

1

[7]

M9. (a) (Chromium =) 20

1

in correct order

(Nickel =) 8

*accept Chromium = 8 **and** Nickel = 20 for 1 mark*

1

(b) (i) (because iron is made up of only) one type of atom

1

(ii) not strong

ignore soft / corrosive / flexible

*accept it rusts / corrodes **or** that it could wear away*

accept could change shape / bend

accept layers / atoms could slide (over each other)

1

(iii) has different sized atoms / particles

or

structure is different/distorted / disrupted

*accept not in layers **or** not regular*

1

so it is difficult for layers / atoms / particles to slip / slide (over each other)

accept layers cannot slip / slide

1

[6]

M10. copper collects at the negative electrode

copper positive ions

each for 1 mark

[2]

- M11.** (a) *ideas that it is a*
- compound of metal/metal oxide/combined (NOT mixed) cpd/
named cpd $O^{2-}/S^{2-}/CO_3^{2-}$ etc
 - found naturally/in rocks/in Earth's Crust
for 1 mark each
- 2
- (b) reduction (accept smelting/refining but not electrolysis)
for 1 mark
- 1
- (c) One example. Al or above in Reactivity Series
ie Group I or II metals NOT Pb/Cu or compounds
for 1 mark
- 1
- [4]**

- M12.** (a) (i) 5(%)
- 1
- (ii) 0.35
- $$\frac{5}{10} \times 7$$
- for 1 mark*
- 2
- (b) (i) reduction
accept (it's) reduced
*do **not** accept redox / deoxidation*
- 1
- (ii) heat with / reduce / react with **or** (chemical) reaction
- 1
- with a metal / element / substance higher in reactivity
ignore displace
*accept higher named elements **or** symbol*
accept carbon monoxide / coal / coke
correct word equation for 2 marks
correct formulas for 1 mark
correct balanced symbol equation for 2 marks
- 1

or

electrolysis:

molten

electrolysis

(1)

(1)

[6]

M13. (a) 2,4

allow electrons in any position on correct shells

1

(b) (electron) 79

1

neutron

allow phonetic spelling

1

118

1

(c) (i) 16 **and** 9

in this order

1

(ii) any **two** from:

ignore reasons about colour / lustre / corrosion / rarity

- (100% / pure) gold is soft
allow layers can slide in pure gold
- (alloyed) to make the metal hard(er)
ignore just 'the ring is an alloy'
allow (alloyed) to stop the layers sliding
allow (alloyed) to make the metal strong
- gold is expensive **or** alloy is less expensive

2

[7]

M14.	(i) idea that: carbon is above lead in the reactivity series <i>for 1 mark</i>	} NOT	
	carbon is below aluminium in the reactivity series <i>for 1 mark</i>	} OXIDE	
	carbon can remove oxygen from/reduce lead <u>oxide</u> or cannot remove oxygen from aluminium <u>oxide</u> not aluminium more reactive than lead <i>for 1 mark</i>		
	OR similar ideas in comparing bond strengths		3
	(ii) (carbon + lead oxide) → * <u>lead</u> + * <u>carbon dioxide</u> <i>each for 1 mark</i>		
	accept correct formulae CO ₂ and CO NOT carbon oxide		2
			[5]
M15.	(a) (because to produce low-carbon steel) oxygen is needed to react with / oxidise carbon <i>accept (to produce low-carbon steel) oxygen removes carbon as carbon dioxide</i>		1
	(to produce titanium) an atmosphere of argon is used because it is unreactive		1
	any oxygen / air would react with / oxidise magnesium or titanium <i>ignore magnesium chloride / titanium chloride reacts with oxygen</i>		1
	(b) for titanium: <i>it = titanium</i> <i>ignore references to abundance / usefulness / temperature / amounts / relative reactivity / equipment</i> <i>allow converse arguments for iron</i>		
	• there are more stages in its manufacture <i>accept slower rate of production or is more labour intensive or a batch process is used or the process used is not continuous</i>		1
	• larger amounts of energy are needed <i>accept the titanium chloride is cooled and reheated which is not energy efficient</i>		1
	• magnesium / chlorine / argon have to be produced or are expensive or are used		1

- (c) titanium is below magnesium and above iron (in the reactivity series of metals)
allow similar position to aluminium or carbon or zinc

1

because magnesium removes chlorine from titanium chloride **and** titanium removes oxygen from iron oxide

allow magnesium displaces titanium and titanium displaces iron

1

OR

magnesium more reactive than titanium because it removes chlorine from titanium chloride (1)

accept magnesium more reactive than titanium because it displaces titanium

titanium more reactive than iron because it removes oxygen from iron oxide (1)

accept titanium more reactive than iron because it displaces iron

[8]

- M16.** (a) (i) reacts with carbon / C
accept burns / oxidises carbon

1

carbon dioxide / CO₂ / gas is formed / given off

accept carbon monoxide / CO

accept correctly balanced equation for 2 marks

ignore state symbols

1

- (ii) change / improve properties
accept any specific property
accept to make alloys / special steels
ignore brittle

1

(b) any **two** from:

- to conserve ores / iron
accept ores / iron are non-renewable / non-sustainable
allow less quarrying / mining
- to prevent the use of landfills
allow reduce waste
- to conserve energy / fuel
accept fossil fuels are non-renewable
- to reduce carbon / carbon dioxide emissions
- to meet EU / International targets
ignore costs / demand

2

[5]

M17. (a) mixture

not compound

1

of a metal with other element(s) / metals

not of elements

not of a metal with other substances

1

(b) steel

allow stainless steel

1

(c) stronger / increased strength / harder / less malleable / less brittle

not corrosion / rusting

1

(d) copper and zinc

1

[5]

